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10th Part of AAEE/853/2

MINISTRY OF SUPPLY

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN

WYVERN S. MK.4 VW.884
(PYTHON 3)

QUALITATIVE LONGITUDINAL AND LATERAL HANDLING TRIALS UP TO 20,000 ft. INCLUDING STALLS

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1. Introduction

VW.884 was a Mk.4 Wyvern and was delivered to this Establishment for full handling trials in connection with C.S.(A) clearance of the type. Various detailed aspects of the handling behaviour have been covered in other parts of this report, and these showed the need for improvement in some features before C.S.(A) release could be granted completely or in part. The two main points which arose were (a) inadequate elevator control for deck landing at forward c.g. positions, and (b) overbalance of the rudder in sideslips on the climb. Despite this, and in the interests of expediency, it was decided to report qualitative handling trials, but leaving out as far as possible those aspects of handling likely to be changed as a result of development to improve the known adverse features.

This part of the report therefore covers some aspects of qualitative handling, but excludes directional characteristics and take-offs and landings since these are covered in other parts of this report.

It may be noted here that the overbalance problem appears to have been cured by the fitting of subsidiary fins on the tailplane; these may have an effect on longitudinal characteristics but this will have to be checked later. It should be noted that tailplane fins were not fitted during these tests reported here. Also, it seems that the elevator problem in A.D.D.L's may be solved more easily by changes in the propeller pitch mechanism than by changes in the tail-plane or elevator.

2. Condition of aircraft

2.1 General. The aircraft was as described in the 2nd part of this Report.

2.2 Loading. The following loadings were used for the tests.

Loading	Take-off weight(lb)	C.G. position in inches aft of datum and %S.M.C.			
		Undercarriage down		Undercarriage up	
		Inches	%S.M.C.	Inches	%S.M.C.
I	20,730	6.0	21.2	7.2	22.5
II	17,850	1.0	16.0	2.2	17.3

2.3 Airframe limitations. These were taken from the R.D.A. Form 13 dated 17.7.52 and apply to the aircraft without external stores.

Maximum permissible speed	435 kts. I.A.S.
" speed with flaps at manoeuvre position	305 " " ϕ
" " " " down	172 " " ϕ
" " " undercarriage down	172 " " ϕ
" " for operating hood	206 " "
" design Mach number	0.78 indicated

ϕ These were also the maximum speeds for operating the flaps and undercarriage.

Maximum permissible accelerometer reading (at a weight of 20,700 lb.)	6.5 'g' at speeds up to 350 kts. I.A.S. decreasing linearly to 5.6 g at 435 kts. I.A.S.

2.4 Airframe details

2.4.1 Control surfaces. Drawings of the elevator, ailerons and rudder are given in the 2nd part of this report.

(a) Tailplane and elevator. The tailplane had 10° dihedral and increased area compared with the Mk. 2 Wyvern.

/The.....

The port side of the elevator was fitted with a spring tab, and the starboard side with a combined trim and balance tab (0.59:1 balance action).

The subsidiary fins were not fitted during these tests.

(b) Ailerons. Both ailerons were fitted with spring tabs and, in addition, the port aileron had a trim tab.

(c) Rudder. Details of the rudder were not particularly relevant to this part of the report, since the directional characteristics were the subject of separate detailed qualitative investigation and the rudder underwent several changes during the investigation. (see, for instance, the 3rd and 8th parts of this Report).

2.4.2 Flaps. These were in two sections, i.e., inner and outer flaps. The inner flaps were Youngman type having four positions; Up (housed), manoeuvre (lowered and inclined 10° to datum), take-off (20°) and landing (39°). The outer flaps were of the plain hinged trailing edge type. They were inoperative throughout these tests.

2.5 Engine and propeller installations.

2.5.1 Engine. This was a Python Mk.3 No. ASP.239/A.644632, the cowling for which was cut back 14 ins. compared with the Mk.2 Wyvern. The operating limitations were as follows:

Condition	R.P.M.	Jet pipe temp. °C.	Time Limit
Take-off	8000	590	5 mins.
Operational necessity	8000	590	"
Intermediate	7800	560	30 mins.
Max. continuous cruise	7800	530	No limit
Flight idling	7800	580	"
Ground idling	4000	580	"

Maximum permissible torquemeter reading - 340 lb./sq.in.

2.5.2 Propellers. These were Rotol 8-blade contra-rotating of 13 ft. diameter, type RF.75/4-40-5.5/5 (front) and RB.75/4-40-7.5/5 (rear). They differed from those used on the Mk. 2 Wyvern in having increased taper from approximately 0.7 radius to the tip.

The flight fine pitch stop setting was $24\frac{1}{2}^{\circ}$.

2.6 Airspeed system. This consisted of a Mk. 8M pitot head under the port wing and a static vent on the port top side of the fuselage about 4 feet forward of the fin leading edge.

2.7 Instrumentation. Hussenot A.20 continuous trace recorders were used to record height, indicated airspeed, elevator stick force, elevator angle and normal acceleration.

Fitted in the cockpit were a Machmeter, and a desynn to record elevator tab angle.

3. Scope of tests

The tests were primarily qualitative and consisted of assessments of the longitudinal and lateral handling qualities on the climb, in cruising flight, in the dive and on the glide, behaviour at and near the stall and flight under instrument conditions and in turbulent air. Comments were also made on take-offs without flap and on handling with the flaps extended to the manoeuvre position.

/Stalls....

Stalls with flaps and undercarriage down were reported in the 2nd part of this report, but are repeated here for completeness, with stalls with the flaps and undercarriage up.

The foregoing tests were made first at Loading I, some being repeated at Loading II (the practical forward c.g. without external stores).

No assessments of the take-off (other than with flaps up, as stated above) the approach or airfield landing are given in this part of the report, since these have already been reported in some detail in the 2nd ("Airfield deck landing assessment") 4th ("Assessment of lockable tailwheel") and 7th ("Airfield landing assessment") parts of this report, to which the reader is referred.

All tests were made below 20,000 ft.

4. Results of tests

As stated in para. 2.4.1. (c) the rudder configuration was not finalised. References to 'controls' in the rest of this part of the report therefore implies 'elevator and ailerons' unless otherwise qualified.

Due to lack of markings on the elevator trimmer handwheel, all elevator trim positions are quoted as fractions of the tab movement either way, as obtained from the instrumentation.

Unless stated otherwise, all results are for Loading I (aft limit).

4.1 Climb. The aircraft was trimmed at 165 knots I.A.S. and intermediate power (7800 r.p.m., approximately 220 lb./sq.in. torquemeter reading). The elevator and aileron trimmers were neutral.

The controls were reasonably light and effective and moderate in response. The aircraft maintained trimmed flight with hands off for at least a minute in smooth air, any later deviations from the trimmed conditions being small and easily corrected. The deviations were greater but not embarrassing in rough air.

The control column was pushed forward sharply to give an accelerometer reading of about 0 g and then released; it self-centered immediately. Speed increased to about 220 knots I.A.S. in 20 seconds and then reduced to 175 knots I.A.S. after about 50 seconds. It continued to fall gradually, and a very light push force was then used to return the aircraft to the original condition. (A Hussenot record of this is shown in Fig.1). On applying positive 'g' sharply (about 1.5 'g' accelerometer reading) and releasing the control column, it self-centred immediately and the speed reduced to about 130 knots I.A.S. in 15 seconds. The aircraft maintained this speed, a very light push force being used to regain the original speed of 165 knots I.A.S.

The ailerons were deflected by about one third of the travel in either direction and then released. The control column centred immediately and the aircraft resumed lateral level in a dead-beat motion.

There was no sign of elevator or aileron overbalance.

Similar behaviour in the foregoing tests was apparent at Loading II.

There was no marked difference in the handling characteristics at altitude (about 20,000 ft), except that with the lower airspeeds, the controls appeared to the pilot to be slightly lighter and less responsive.

4.2 Cruising flight. The aircraft was trimmed in level flight at about 10,000 ft. at speeds between 160 and 260 knots I.A.S. Over this speed range the aircraft was pleasant to fly hands on, in smooth or bumpy air, and maintained the trimmed condition in smooth air for at least a minute hands off, any deviations being small and easily corrected. The controls were moderately heavy and moderate in response throughout the speed range.

/At.....

Loading and wt. at stall.	Condition	Trimmed speed and trim positions.	Characteristics	
			Before Stall	At Stall
II 17070 lb.	Power off throttle at flight idle gate.	120 knots IAS El. 0.4 n.u. Ail. 0. Rud. 0.	Similar to the above. Slight buffet at 105 knots IAS.; large aileron movements necessary to maintain lateral level.	Stall at 98 knots IAS with starboard wing and nose drop; wing drop could be held on ailerons. Elevator pull force about 2 lb. with just under ½ backwards stick movement. Recovery as above.
II 17,000 lb.	" Stops in.	As above.	As above; r.p.m. started to drop at 115 knots I.A.S.	As above; r.p.m. at stall were 7,500.

4.5.2 Straight stalls, flaps and undercarriage down

I 19620 lb.	Power off, throttle at flight idle gate.	105 knots IAS El. 0.4 n.u. Ail. ⅛" r.w.d. Rud. 0.	Very light pull forces were needed to reduce speed. At 98-99 kts. the port wing started to drop, but this was held easily by the use of stbd. aileron. Very light buffet was felt at 96 knots. Large aileron movements needed to maintain lateral level.	Stall at 95 knots IAS with slight nose drop and starboard wing drop. Elevator stick force zero at stall with about 2/3 backward movement of the stick. Recovery as above
II 17410 lb.	Power off, throttle at flight idle gate.	110 knots IAS El. 0.8 n.u. Ail. 0. Rud. 0.	No appreciable stick force developed on reducing speed. Very slight buffet at 100 knots, increasing slightly to moderate just before the stall At 96 - 97 knots, large aileron angles were needed to maintain lateral leve.	Stall at 95 knots IAS with nose and wing drop. Wing drop could be held with aileron. Elevator stick force zero at stall, with 2/3 backward stick movement. Recovery as above.
I 19370 lb.	Torquemeter reading 100 lb/sq.in A.D.D.L. approach.	100 knots IAS El. 0.2 n.u. Ail. ⅛" r.w.d. Rud. 0.	At 90 knots the pull force present at higher speeds reduced to zero. Slight dropping of either wing easily checked by aileron. At 86-87 knots, large aileron movements needed to maintain lateral level.	Stall at 85 knots IAS with gentle but uncontrollable nose and starboard wing drop. Elevator stick force zero at stall, with about ½ backward stick movement. Recovery as above.
II 16820 lb.	"	105 knots IAS El. 0.4 n.u. Ail. 0. Rud. 0.	Slight pull stick force to about 88 knots, thereafter lightening. Very slight buffet at 92 knots almost masked by aircraft vibrations. Port wing lowered at about 86 knots and could be raised by very light stbd. aileron force.	Stall at 83 knots IAS with nose drop. Elevator stick force zero with about ½ backward stick movement. Recovery as above.

4.7 Instrument flying. Flight on instruments was assessed during flying in cloud and ground controlled approaches. The aircraft was pleasant to fly under these conditions, and no difficulty was experienced in maintaining steady courses and airspeeds.

4.8 Flight in turbulent air. The aircraft was flown in bumpy air at speeds up to 435 knots I.A.S. and no untoward features were noticed in relation to longitudinal and lateral control.

4.9 Trimming and changes of trim. The aircraft was fairly easy to trim longitudinally and laterally at moderate and high speeds, but accurate longitudinal trimming at low speeds required some care. The elevator trimmer was adequate for all flight conditions tested from the stall to the limiting speed. Changes of trim with speed, power and flaps and undercarriage were small and easily held with one hand. Pilots noted that no lateral retrimming was required from the stall to the limiting speed.

Movement of the oil cooler shutters gave rise to no change of trim.

4.10 Take-off with flaps up. This was made with zero elevator trim setting and showed no materal difference from normal take-offs (2nd part of this Report) other than an increase in take-off speed to about 110 knots I.A.S. (i.e. an increase in indicated speed of about 20 knots).

4.11 Other features. No specific tests were made on the airbrakes, but from experience gained it was considered that they would be satisfactory for service use up to 300 knots I.A.S.; above this speed the changes of trim were too large. Further tests are to be made on the airbrake configuration proposed for full Service use.

No heating was provided, and the aircraft therefore became uncomfortably cold in cold weather and at altitude. On the other hand, ventilation was poor and little or no effect could be felt. This is an important point for hot weather operation on this type of aircraft, where the pilot is sitting in a very effective 'greenhouse'.

Paraffin fumes entered the cockpit at all times and were most unpleasant (it should be noted that use of oxygen at all times is recommended).

View generally was good, although downward vision was rather restricted (since the pilot was sitting directly above the wing) and the view forward in rain was poor, for instance in one A.D.D.L. approach in moderate rain the batsman could not be seen until just before the 'cut'. The poor view in rain was often aggravated by misting and pilots considered that these conditions would preclude operation from a carrier and formation flying.

Vibration was encountered on this aircraft on many occasions. Those vibrations which occurred spasmodically and at various speeds and conditions could be cured or reduced by propeller changes. There was, however, one vibration which seemed to be a feature of this aircraft. This started at about 320 knots I.A.S. and was noticeable on the control column; it increased slightly in amplitude with increasing speed.

5. Discussion of results

5.1 Earlier trials on the Mk.2 variant gave the impression that the Wyvern was, generally, a pleasant aircraft to fly. This impression was confirmed in these present general qualitative handling trials up to 20,000 ft. as far as longitudinal and lateral characteristics were concerned (the reader is referred to other parts of this report dealing with directional characteristics and longitudinal handling in airfield and simulated deck approaches and landings) Particularly good features of the aircraft were the small changes of trim with speed, power and operation of flaps and undercarriage.

/5.2.....

5.2 The tests showed no untoward characteristics up to a Mach number of 0.76 (0.74 indicated). For the purpose of the initial Service release it is proposed that a Mach number limit of 0.7 indicated be applied, which is not restrictive while giving ample margin for safety until more complete tests are made. An increase in this figure is to be expected following these further tests.

5.3 The lack of warning in stalls with flaps and undercarriage down has been criticised previously, and the following is extracted from the 2nd part of this Report:-

"Stall warning in straight flight was limited to wing heavying and lateral unsteadiness and, in some cases, slight buffet. However, the former feature was apparent at the earliest only some 3 knots above the stall and the buffet tended to be masked by general vibration of the aircraft. There was no warning at all during stall tests made in turns in the A.D.D.L. configuration.

The inadequacy of the wing heavying as stall warning was commented on in the 1st and 6th parts of Report No. AAEE/853/1. It may be further noted, with reference to the fact that either wing would drop before the stall, that a similar characteristic may be evident at low speeds with asymmetric disposition of external stores or during a turn.

It is therefore again stressed that some more positive stall warning, artificial if need be, and starting say 5 knots or 0.2 g above the stall, is necessary".

5.4 A vibration which appeared to be a feature of the aircraft has been mentioned in para. 4.10. Vibration records taken by the R.A.E. did not show it to be dangerous, although it was annoying to pilots.

6. Conclusions

These tests confirmed that at heights up to 20,000' the longitudinal and lateral handling qualities of the aircraft were generally pleasant; pilots particularly liked the small changes of trim associated with speed power and flaps and undercarriage. However, there is still need for some form of stall warning. Urgent attention should be given to cockpit heating and ventilation and to the view in rain.

An indicated Mach number of 0.70 is recommended as the maximum for Service use; this may be increased after further tests.

7. Further developments

Subsidiary fins have been fitted to the tailplane since these tests were made, and their effect on handling will be reported in later parts of the Report dealing with directional handling and longitudinal stability. It is clear however that the fins have not appreciably changed the general qualitative aspects covered in this part of the Report.

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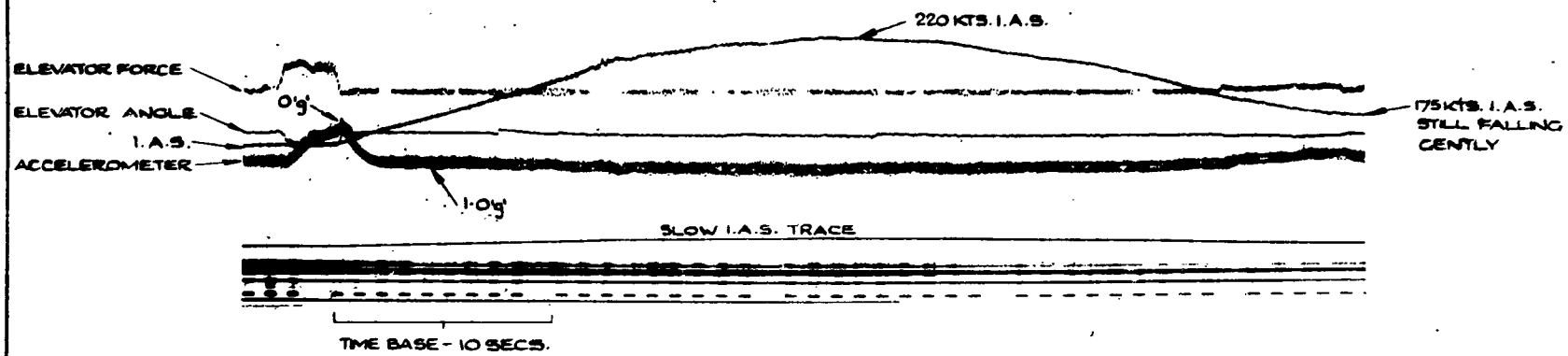

FIG.1.

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